DEPARTMENT: POLLUTION CONTROL AGENCY

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STATE OF MINNESOTA

Office Memorandum

DATE: March 16, 1999

TO: Dale Trippler, project manager
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Faribault Municipal Well Contamination project file

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SUBJECT: **1998 Ground Water Investigation, Project Status and Recommendations for Further Work--Faribault Municipal Well Contamination**

This memorandum summarizes investigative activities performed to determine potential source area(s) of trichloroethene (TCE) that occurs in several municipal wells in Faribault, Minnesota. Field work performed during the mid-1980's and the mid 1990's focused on a confirmed contaminant source area identified at the former Nutting facility, however a certain connection between the Nutting plume and the TCE that occurs in the municipal wellfield was not possible. Subsequently, MPCA staff developed a list of four other potential source areas, which were the focus of the recent (1998) investigation.

The primary goals of the 1998 investigation were to: a) evaluate the likelihood that each potential source area is an actual source of TCE seen at the municipal wellfield; and b) evaluate contaminant flow paths such that a plan for removal of TCE exposure to humans can be formed. To accomplish this, twenty boring locations were drilled in the general area southwest of the municipal well field (figure 1), and ground water was sampled at 2-3 depths within the glacial drift/St. Peter aquifer (hereafter, Qd/OSP). Samples were collected at several depths in each boring to maximize the chance of finding the plume.

Some locations drilled were selected based on file records (documents, airphotos, interviews, etc.) , and focused near and immediately downgradient of potential source areas. The remaining borings were drilled in a data gap located generally between the potential source areas and the municipal wells (figure 1). The field notes (orange field books labeled "Faribault Ground Water Book 1" and "Book 2") contain detailed information on the location of each boring.

Because the drinking water contamination occurs in the Prairie du Chien Aquifer (OPDC), ground water sampling of an adequate OPDC monitoring system will eventually be necessary. The strategy of the 1998 investigation was to use expected contamination in the Qd/OSP to cost-effectively find the contaminant source(s); any released separate phase contamination (DNAPL) may have sunk, but would have passed through all overlying zones, fanning out in a trail of contamination which may still be detectable. Classic porous flow hydrogeology accurately predicts flow in sands and sandstones such as Qd/OSP. Later drilling of the fractured OPDC could then be focused toward definite source area(s). Volatile organic compound (VOC) chemical analyses of the samples indicate the concentration of TCE and related compounds at each depth. Various other analyses (dissolved oxygen, nitrate, iron, sulfate, etc.) indicate the hydrogeochemistry of the system, and the likelihood of the occurrence of natural attenuation of VOCs through reductive dechlorination.

MPCA staff or its contractor screened three depths in each location (figure 2): a) a pushprobe boring to water table for soil and ground water samples; b) a pushprobe boring to approximately 30 feet for soil samples (geologic logging) and a ground water sample; and c) a hollow-stem auger boring to the bottom of the OSP for a water sample from that depth. Minnesota Department of Natural Resources (MDNR) staff performed gamma logging at selected deep borings. All sampling points were abandoned immediately after sampling was complete. The Minnesota Department of Health (MDH) analytical

laboratory analyzed the ground water samples. The following sections summarize the results from borings completed at each of the drilling locations shown on the map in figure 1.

Borings B101-B104--Crown Cork and Seal Facility

Investigative Results. Although Crown Cork and Seal currently occupies the property, it was previously owned and operated by another company (McQuay) known to handle large volumes of TCE. The boring locations were selected after review of facility records indicating the presence of a "waste storage" tank along the northern building wall, and an area designated by "waste stored in drums, temporarily" along the eastern building wall. See figure 3. Borings B101 and B103 were drilled in these locations; B102 and B104 were drilled directly downgradient from these locations (probable ground water flow direction was determined from existing data at numerous leaking underground storage tank sites in Faribault, including the Crown Cork and Seal facility). Field work occurred in April 1998.

Boring depths ranged from 28.5 feet (B103 and B104) to 47 feet (B101). Boring B101 was screened in a brown silty clayey unit and had a poor yield; the other borings were screened in sand, with screens set just above the silty clay unit (based on pushprobe refusal).

Ground water samples were collected from the total depth (approximately 25-30 feet deep, except at B101, 36-40 feet) at each of the four locations. In addition, water table samples were collected in the two locations (B103, B104) where no previous investigation results were available. TCE was not present in either of the potential source area borings (B101 deep, B103 shallow and deep), nor in boring B104 (shallow and deep). A previous investigation detected 2.1-8.4 ug/l TCE at the water table near boring B102, however the TCE was not detected in the deep sample collected from boring B102.

Tetrachloroethene (PCE) was detected at the site in concentrations of up to 34 ug/l (MW-1, Nova investigation, 1993). Under appropriate conditions, PCE degrades to TCE naturally in the subsurface.

Interpretation. The uppermost sandy layer is Qd outwash, continuous across the site (and throughout much of investigated Faribault). The brown silty clayey layer encountered in boring B101 is a likely till layer. Although this unit was only drilled in boring B101, pushprobe refusal at a similar depth in the borings B102, B103, and B104 indicates the till is continuous between the drilled portions of the site (but the till layer was not seen at any other site, including K & G, approximately 700 feet to the north; see below). Based on all borings, the till is at least about 17 feet thick (approximate elevation 966 to at least about 949). Geology beneath approximate elevation 949 has not been drilled, however the OPDC likely occurs at an approximate elevation of 932, similar to its observed elevation elsewhere in Faribault.

The low level detection of several petroleum compounds in boring B101 may have been produced by a nearby exhaust fan during sampling; contaminants have most likely not penetrated the till. Based on the poor yield of B101, the till has low permeability, which along with its inferred thickness suggests it is relatively impermeable to dissolved contaminant migration. It would also be expected to be relatively impermeable to downward movement of separate phase product migration. Any released DNAPL would probably move quickly downward through the sands to the top of the till layer, then laterally along the contours of the top of the till layer (survey elevations indicate the top of the till tilts slightly northeast). A dissolved contaminant plume would then develop in the outwash layer, moving with the ground water flow in that unit, traceable upgradient to the source area.

The screened intervals of borings B102, B103, and B104 were such that ground water was sampled from just above the till layer. The measured range of TCE concentrations in this investigation was non-detectable; earlier ground water samples collected as part of the Tanks/Spills investigation contained TCE in concentrations up to 8.4 ug/l. In view of the "skinny plume" behavior common for chlorinated solvents dissolved in ground water, it is possible that a plume occurs between the investigative boring locations.

Borings B201-B204, K & G Mfg. facility

Possible source areas at the K &G facility were identified by file review, examination of airphotos, and site visit. The K &G plant manager confirmed there have been two distinct disposal pits in use during the time this facility has been active. Three water table monitoring wells were drilled and sampled in the middle 1980's near the existing disposal pit, but none were downgradient of the pit. Analytical results in these wells indicated TCE was present at background levels (BDL to 0.40 ug/l).

MPCA's contractor drilled four borings in July 1998; two were located very near the existing and former disposal pits (B203 and B204), and two were located in positions downgradient (northeast) of the first two borings (B201 and B202), with estimated ground water flow direction from existing monitoring wells (see figure 4). The uppermost materials encountered during drilling were poorly graded fine to coarse sands with some gravel, to a depth of at least 35 feet. Auger refusal in each borehole occurred at depths ranging from 56-61 feet.

Ground water purging and sampling was performed by peristaltic pump, except in the deepest sampled intervals, where bailing was necessary due to low yield. Ground water quality in the water table zone was characterized by petroleum compounds at low concentrations (<1 ug/l), TCE from 0.2-8.4 ug/l, and PCE and 111TCA present from trace levels to 2.3 ug/l. The 31-38 foot deep zone was characterized by TCE in concentrations ranging from trace to 1.1 ug/l, 111TCA from trace levels to 8.6 ug/l, and other solvent VOCs in minor amounts (MIBK, 11DCA). Petroleum compounds were also present in boring B204 (toluene, <1 ug/l; xylene 4.8-12 ug/l). TCE was not detected in ground water from the deepest zone, although petroleum compounds (xylenes, toluene), 111TCA and MEK were all present in minor amounts.

Interpretation. The geology beneath the site consists of Qd glacial outwash underlain by bedrock. There was no evidence of the brown till layer seen at the Crown Cork and Seal facility. The Qd beneath the K &G facility extends to a depth of approximately 35-40 feet, and is underlain by OSP. The presence of fine gray sand in the purge water of boring B203 (deep) indicates the probable presence of the shaley beds of the lower OSP. The lower OSP is probably continuous beneath the site (as indicated by poor yields from these wells), although cuttings were not collected at a depth to confirm this. All four borings ended at the inferred top of the OPDC.

The company insists that chemicals were never put into the pits. The occurrence of solvents at the water table and at 31-38 feet is inconsistent with the company's position, although these detections could represent VOCs originating upgradient of K & G. The petroleum compounds are present in concentrations below that which would cause concern. MIBK and 111TCA do not occur in the municipal well system and therefore are not of primary concern in this investigation.

After the investigation was complete, I discovered that the southeastern portion of the K & G property was formerly the waste storage area, and its exact location is evident on the 1979 airphoto. This area was not a part of the investigation. Because a leaky waste storage area could have been a contaminant source, further proposed investigation should address this area.

Boring B701-B702, Mercury Minnesota

Mercury Minnesota claims never to have used TCE in its process, but has been included in this investigation primarily because TCE was found in water table and OPDC sample water. The drilling locations for this investigation were selected as follows: B701 was drilled close to the area where previous water table monitoring wells drilled as part of a leaking tank investigation discovered trace amounts of TCE; B702 was located adjacent to former MPCA OPDC monitoring well MW-1(now abandoned), in the eastern portion of Mercury of Minnesota property. The boring locations are indicated on figure 1.

Boring B701 encountered poorly graded medium to coarse sands to a depth of 19 feet. The pushprobe was advanced to refusal at approximately 21 feet, and retrieved a core of white fine grained sandstone. Auger refusal occurred at a depth of 36 feet. Boring B702 encountered fine to medium poorly graded sands with some gravels to a depth of at least 21 feet. A core retrieved from a depth of 24-26 feet contained white

sandstone. Hollow stem augers were advanced to 32 feet. Ground water contaminants detected included TCE (0.5-7.9 ug/l), PCE (0.2-7.0 ug/l), cis 12DCE (0.3-3.8 ug/l), and 11DCA (0.5 -12 ug/l).

Interpretation. The site geology is similar to the sites described above. The site is closer to the Cannon River than the others, and the surface elevation is somewhat lower, with a decrease in the bedrock depth. The sandy zone is Qd glacial outwash, with a thickness of 21 feet near Hulet Avenue (B701), and 21-24 feet at the eastern end of the property (B702). The OSP is present beneath the Qd to a depth of 36 feet, where the inferred top of the OPDC was encountered in boring B701.

The screened interval of boring B701 was 32-34 feet, and the temporary well built in the boring had a very low yield. Upon removal, the screen contained greenish light brown sand indicative of the basal shaley beds of the lower OSP. The well installed at boring B702 was screened slightly higher (29.5-32 feet), and purging by peristaltic pump was possible. It is therefore likely that boring B702 was screened above the basal OSP shaley beds, inferred to be present at a depth of about 31-36 feet.

The ground water chemistry of borings B701 and B702 indicates that TCE and other chlorinated volatiles are present in most samples at relatively low concentrations; the exception is the water table sample from boring B702, in which PCE was detected at the HRL (7 ug/l). This boring is located only 500 feet from CW-4. Neither the distribution of PCE nor the ground water flow direction in this location are known. The presence of PCE in the ground water at this location is not consistent with Mercury Minnesota's documentation indicating that PCE is not used at the facility.

Borings B301, B401, B501, B601 and the B80X series

The remaining borings were drilled in the portion of Faribault located between the possible source areas described above and the municipal well field (figure 1), as follows:

- B301 was located at the northeast corner of Lincoln Park, corner of 7th Street NW and Lincoln Avenue, adjacent to former OPDC monitoring well MW-2;
- B401 was located on 8th Street where it dead ends on the west side of the railroad tracks;
- B501 was located immediately west of municipal well #4;
- B601 was located in an alley north of 7th Street NW, just east of Hulet Avenue;
- B801 was located at the southeast corner of Lincoln School, at the corner of George Street and Lincoln Avenue;
- B802, B803, B804, B805, and B806 were drilled to be better define the contaminants identified at boring B801.

The geology encountered in these borings was similar to that encountered in the other borings. The sandy zone was present in thicknesses up to approximately 38 feet, underlain by sandstone, and auger refusal at depths of 38 to 47 feet.

Ground water samples collected from these borings contained varying concentrations of numerous VOCs, including: PCE; toluene, 111 TCA, TCE, xylenes, benzene, 11DCA, cis12DCE, ethylbenzene, and others. For the complete list of chemicals detected and associated concentrations, see attached table ("Summary of Chemical Results").

Interpretation.

The results from boring B801 confirm that at least part of the plume reaching the city wellfield originates southwest of the wellfield. The water table sample contained PCE at 33 ug/l and TCE just above the detection limit, but the TCE concentration at depth was 590 ug/l (with PCE just above detection). These conditions are indicative of a dissolved solvent plume, perhaps even near the axis of the plume, and are consistent with geochemical results of natural attenuation parameters indicating reductive dechlorination occurs at depth. Subsequent borings drilled as a result of this finding (B802-B806) indicate a northeastward migrating VOC plume, the flanks of which are defined approximately by borings B803 and B805, and the axis of which is defined approximately by borings B801 and B804 (figure 5).

The data indicate that at least a portion of the TCE plume reaching the city wellfield actually originates as a PCE plume upgradient (southwest) of borings B801 and B804. No PCE usage is documented by either Nutting, Crown Cork and Seal, McQuay nor K & G, however all but Crown used TCE for parts washing and other similar activities, and it is not inconceivable that PCE was occasionally substituted for TCE.

Hydrogeology favors plume origin from the vicinity of Crown/McQuay or K & G, but not Nutting. Ground water elevations indicate generally northeasterly flow towards the wellfield, consistent with a ground water flow model for the city submitted to the MDH wellhead protection program. Neither is consistent with plume origin at Nutting. A Qd/OSP pumpout system operating at Nutting since the 1980s intercepts TCE migrating from that site, and no TCE plume in the OPDC has been found in connection with Nutting. In addition, the consultant for Nutting indicated that PCE has never been detected at that site.

Discussion

The ground water investigation results allow several conclusions to be drawn on the following issues: source areas; contaminant transport; natural attenuation; screening criteria; remediation of the VOC plume(s) vs. removal of exposure.

Source areas. Most borings did not encounter a distinct VOC plume, and none defined a definite source area. However boring B801 intersected a VOC plume very near its probable axis. Subsequent borings B802-B806 further defined the shape of the plume. The apparent northeasterly plume migration is consistent with approximate ground water flow directions measured at nearby petroleum investigation sites, and suggests a plume source southwesterly along a line defined approximately by borings B801 and B804. The properties currently occupied by Crown Cork and Seal and K & G Manufacturing are located in the apparent upgradient direction and may be source areas of the plume.

Analytical results from boring B702 indicate a probable PCE/TCE source area near this location on the Mercury Minnesota property. There are no known activities near this location consistent with a PCE/TCE source, however abandoned barrels and pits possibly used for waste disposal are present at the nearby CMC-Heartland property (directly east; downgradient of B702, very near CW-4).

Results measured at boring B701 and former monitoring well MW-1 may indicate the presence of a VOC source area upgradient (west) of Mercury Minnesota.

This investigation did not determine whether the Nutting site has contributed TCE to the plume seen at the municipal wells, although it seems unlikely that the known Nutting TCE plume in the Q/OSP causes the plume seen at borings B801 and B804 (based on apparent ground water flow directions and chemistry, and the presence of the pumpout system). This investigation did not evaluate ground water chemistry in the OPDC, and therefore gives no information on whether the Nutting TCE plume has affected the OPDC.

Contaminant transport. No exact VOC source area has been identified, so the following description of contaminant transport pathways is general. A conceptual cross-section of the contaminant plume is shown in figure 6. The detected VOC plume is in the dissolved phase, and moves advectively through the Qd under a slightly downward northeasterly gradient. Approaching the drawdown cone of the pumping municipal wells, its pathway steepens through the Qd and into the OSP.

The presence of highly contaminated water in the OSP shaley beds (B801) indicates significant downward leakage through the shale; high leakage rates may be present only where the drawdown cone of the municipal wellfield provides a strong downward gradient. Common zones of lost circulation during drilling of many borings at this depth in this area may indicate an uppermost OPDC zone where rapid lateral contaminant transport occurs, particularly close to the municipal wellfield.

The brown till beneath Crown Cork and Seal, while observed at B101 and assumed continuous across the property, is not present at K & G (approximately 700 feet north of Crown), or at any other drilled location. The till is expected to be relatively impermeable to dense, separate phase liquids (DNAPLs), although none

have been observed during this investigation. DNAPL material, if present, would likely have migrated to the outwash/till contact, then along this surface under gravity flow until falling off the edge of the till into the outwash. The till topography is probably essentially flat, tilting slightly northeastward.

Natural attenuation. Measurements designed to evaluate the likelihood of natural attenuation indicated the presence of aerobic conditions at the water table, with increasingly reducing conditions at depth. Chlorinated compounds such as PCE would not dechlorinate in the aerobic zone, but would with depth. The VOC chemistry of the ground water is consistent with this scenario (very low PCE detections with depth, increased TCE detections with depth; some detections of cis-12DCE and vinyl choride), suggesting that natural attenuation of PCE and TCE does occur.

However, in the OPDC, lateral transport is apparently dominant over natural attenuation, because TCE appears very near CW-4 (MW-1; MW-502) and in CW-4. Therefore natural attenuation is not an adequate remedy in this hydrogeologic setting.

Screening criteria. Screening criteria guide the need for further investigation, and serve as potential cleanup goals for the site. Screening criteria for the compounds of concern are presented below. The compounds of concern are PCE, TCE, c-12DCE, and vinyl chloride (VC). The screening values are based on the MDH Health Risk Limits (HRLs; state drinking water criteria), and the Maximum Contaminant Limits (MCLs; federal drinking water standards, which are applicable to municipal drinking water wells).

Compound	HRL (ug/l	MCL (ug/l)
PCE	7	5
TCE	30	5
cis-12DCE	70	70
VC	0.2	2

Remediation versus removal of TCE exposure

Investigation and previous data show that the VOC plume is extensive in both the Q/OSP and the OPDC. This fact, coupled with expected difficulties remediating a fractured carbonate aquifer, suggest that ground water remediation would not be effective. The documented occurrence of TCE in the municipal drinking water wells since the early 1980s suggest that a pump/treat remedial approach would be long-term to very long-term, and therefore very costly. Other approaches would be of uncertain effectiveness, and perhaps similarly costly.

Therefore removal of human exposure to VOCs will depend not upon remediation, but upon deactivating and/or rebuilding the city wells. Rebuilding the city wells such that they draw water from a single aquifer (Jordan) will depend upon the presence of a laterally continuous confining layer between the Shakopee Formation and the Jordan to ensure the contaminant plume is not pumped downward to the Jordan Aquifer by the newly rebuilt wells. In some locations of southeastern Minnesota, such a confining layer is present, but extrapolation to Faribault is risky with no test data.

Further work needed:

On the basis of this and previous investigations, two major items remain to be evaluated: 1) continue to define probable source areas; and 2) evaluate the proper actions to remove exposure to TCE at the wellhead.

Define source areas. The primary potential source areas are properties currently occupied by Crown Cork and Seal, and K & G Manufacturing. Secondary potential source areas are upgradient (west) of Mercury Minnesota, the area near boring B702/MW-1 at Mercury Minnesota, and the CMC-Heartland property. MPCA position with regard to the Nutting TCE source area is not addressed in this memorandum.

The primary potential source areas should be investigated again by pushprobe. Borings are to be located as follows: a) at Crown, borings will be located at approximate 50 foot intervals along the northern and

eastern building walls to determine whether a VOC plume is migrating from beneath the building, and to determine the northern extent of the till; and b) at K & G, borings will be located at 50 foot intervals along the western curbline of Park Avenue (city property). The water table and a deeper interval will be sampled in each location for VOCs and natural attenuation parameters. Ground water elevations will also be measured to determine ground water flow direction.

Investigation of the secondary source areas may be performed at a future time.

Removal of TCE exposure. If CW-4 and the other municipal wells are to be rebuilt as Jordan Aquifer wells, we must first be sure that this configuration will not pump contaminated ground water from the Shakopee across the Oneota formation to the Jordan. Monitoring wells MW-502 (Shakopee) and MW-503 (Jordan) were recently completed within 50 feet of CW-4, and a water table monitoring well (MW-504) will also be installed soon. The anticipated tests listed below will help determine the hydrogeologic feasibility of rebuilding the city's drinking water wells (the engineering is to be evaluated by others):

- water level measurements to determine vertical gradients between the Shakopee and Jordan under pumping and non-pumping conditions (CW-4);
- chemical testing to determine vertical distribution of VOCs in the Shakopee and Jordan near the wellhead;
- testing provided by the United States Geological Survey (USGS) to profile flow and hydraulic conductivity in MW-502. This will help determine the exact depth within the Shakopee formation that produces the contaminated water that eventually appears in CW-4. Casing off the contaminated interval will be an integral step in rebuilding the city wells (if this plan proceeds). This test is anticipated for March or April 1999;
- aquifer pumping test to determine hydraulic connection between the Shakopee and Jordan. The test will be arranged in consultation with the MDH SAC and wellhead protection programs, and will be designed to measure response in MW-502, MW-503 and MW-504 while pumping CW-4 over a minimum 24 hour period.

If there are any questions about this memorandum, I can be reached at the telephone number on the first page, or at <jim.lundy@pca.state.mn.us>

I hereby certify that this document was prepared by me (or under my direct supervision) and I am duly certified as a Professional Hydrogeologist under the Rules and Regulations of the American Institute of Hydrology.

Print Name: James R. Lundy
Date: 3/16/99

Signature: James R. Lundy
License: #1485

EPA Regions should reflect plans to conduct five-year reviews in their annual Superfund Comprehensive Accomplishment Plan (SCAP) or other appropriate strategic planning and budgeting system. The fiscal year 1992 Program Management Manual and other planning documents will address the level of activity associated with such reviews. The Regions must also capture the site-specific costs associated with five-year reviews and reflect them in the Software Package for Unique Reports (SPUR) or other Regional cost summaries.

G. Public Participation

EPA will inform the public when it determines that either a Statutory or Policy five-year review is appropriate, describe the planned scope of such reviews, identify the location of the report on the review (see section V below), and describe actions taken based on any review.

Beginning in fiscal year 1990, each ROD attempts to identify whether a statutory or policy five-year review is appropriate for the site based on the nature of the remedy. A discussion of the five-year reviews in subsequent proposed plans will afford the public an opportunity for comment on whether a five-year review is appropriate for the remedy and the general scope and timing of such reviews. In conducting reviews, EPA Regions should inform local communities of pending reviews and consult with the community in developing a communication strategy. As stated below, the Five-Year Review Report should be made available to the public through the administrative record file.

H. Level of Review

EPA contemplates that a Level I analysis will be appropriate in all but a relatively few cases where site-specific circumstances suggest another level either at the outset of the review, or if findings during the course of the review indicate the need for further analysis.

EPA will determine the level of the review based on site-specific considerations, including the nature of the response action, the status of on-site response activities, proximity to populated areas and sensitive environmental areas, and the interval since the last review was conducted. Level I is the lowest level of evaluation of protectiveness, Level II is the intermediate level, and Level III is the highest level of evaluation of protectiveness. EPA contemplates that a Level I analysis will be appropriate in all but a relatively few cases where site-specific circumstances suggest another level. A Level II review would be appropriate only if warranted by site conditions. For example, the absence of expected change in the level of contaminants, as monitored, might suggest additional

Moemorandum to the file

Maureen Johnson
December 5, 1994

Meeting with Miriam Horneff regarding 5-year reviews and public participation.

I inquired about compliance with the public participation aspect of 5-year reviews (Attachment I, III. G. Public Participation, of OSWER Directive 9555.7-02). I noted that it wasn't clear to me at what point the RP and the public should receive a copy, draft or final.

Miriam explained that the federal Office of the Inspector General has prompted EPA to provide only the final report to the public and the RPs for comment. This policy arose out of the concern that the opportunity for coercion be minimized.

I note upon further review of the above document that public comment is solicited at the time of proposed plans as to whether the 5-year-review is appropriate, and that the final report should be made available to the public through the administrative record. V. says that EPA will notify communities of on-site review activities (inspection), actions proposed on the basis of the review, and the location of the administrative record file.